

# **Space-Borne Radio-Sounding Investigations Facilitated by the Virtual Wave Observatory (VWO)**

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(Paper HG2.4 on 17 August at the 2011 URSI General Assembly)

## Outline

- The Virtual Wave Observatory (VWO)
- Alouette-2, ISIS-1, and ISIS-2 digital topside-sounder ionogram data
- Alouette/ISIS search page
- Science projects aided by the search page
- Alouette/ISIS merged data files on CDAWeb
- Alouette/ISIS ionogram data access via the VWO
- Encourage investigators to make other space-borne sounder data sets accessible via the VWO



+ Home

## Virtual Wave Observatory

+ Data Query

+ Tutorials

+ Education

+ Annotation Service

+ Event Lists, Products  
and Tools

+ VWO Data Resources

+ Registered Data Inventory

+ Data Registration Plan

Other Heliophysics Data  
Links

The VWO vision is to enable sharing of Heliophysics wave data and expert knowledge. The goal of VWO is therefore to make Heliophysics wave data searchable, understandable and usable by the scientific community.

# Fung [2010]

## VWO Services

### Data Query

The methods you can use to find data.

### Tutorial

A Primer on the use of wave data in Heliophysics research and examples of the VWO in action.

### Education

The different kinds of waves in the Heliosphere: Where they are, what they are like, and what we can learn from them.

### Annotation Service

Wave emissions don't come with labels. Here is where we add them.

### Data Providers

How to register your data to make it searchable through the VWO.

## Related Sites

[SPASE - Space Physics Archive Search and Extract](#)

[Heliophysics Data Environment](#)

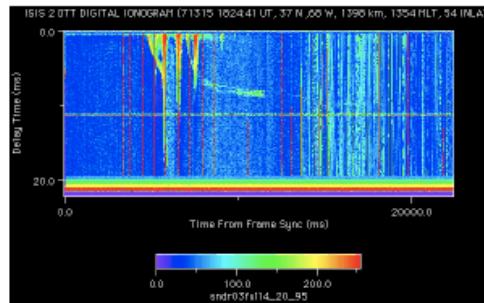
## Wave Research Resources

### Research Groups

- + Iowa Radio and Plasma Wave Group
- + U. Maryland/IPST Space & Upper Atmospheric Physics Group
- + Stanford VLF Group
- + Swedish Institute of Space Physics, Uppsala (IRFU) Wave Group

### Information

**Alouette-2, ISIS-1, and ISIS-2 digital topside-sounder ionogram data available from**  
[\*\*http://nssdc.gsfc.nasa.gov/space/isis/isis-status.html\*\*](http://nssdc.gsfc.nasa.gov/space/isis/isis-status.html)  
**Also locate data via multi-parameter search page**



**Benson and Bilitza [2009]**

## **ISIS/Alouette Topside Sounder Data Restoration Project**

- Read about the project
  - [background information](#)
  - [data selection criteria](#)
  - [analog-to-digital \(A/D\) operation](#)
  - [how to detect erroneous files](#)
  - [analysis of digital ionograms](#)
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Includes all ISIS-1 and -2 standard resolution ionograms in CDF format (skeleton\_tables: [ISIS-1](#), [ISIS-2](#)). First time users please read the separate [Comments](#) and [Viewing Instructions](#).
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  - [Topside electron density profiles](#) obtained with TOPIST
  - [Electron density profiles](#) obtained by manual scaling in the seventies.
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  - Binary full resolution ionograms with 3.75 km apparent-range resolution instead of 15 km for the standard ionograms [[ISIS-1](#) and [ISIS-2](#) format description]
  - Telemetry-level Pulse Code Modulation data for all ISIS 2 instruments [[PCM format description](#)]
- [Locate](#) data for specified dates, times and other search criteria. Currently only ISIS-2 data are considered.
- [Related software \(retrieve source code\)](#):

← **link to search page**

# ISIS-2 DIGITAL TOPSIDE SOUNDER DATA SEARCH PAGE:

---

TYPE OF SEARCH:	PASS	IONO				
	<input checked="" type="radio"/>	<input checked="" type="radio"/>				
<hr/>						
	MINIMUM	MAXIMUM	ON	OFF		
Year (YYDDD)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	STATION CODE	<input type="text"/>
UT (HHMM)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	ORBIT NUMBER	<input type="text"/>
LMT (HHMM)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	SUNLIGHT	yes <input checked="" type="radio"/> no <input type="radio"/>
MLT (HHMM)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
DIP (-90 to 90)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
CHI (0 to 180)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
GGLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<a href="#">Need Help</a>	
GGLON (-180 to 180)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
HGT (1300-1500 km)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
GMLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
GMLON (-180 to 180)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
FH (0.3 - 1.1 MHz)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
INVLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
L value	<input type="text"/>	<input type="text"/>	<input type="radio"/>	<input type="radio"/>		
			DMODE	<input type="radio"/>	<input checked="" type="radio"/>	
			GMODE	<input type="radio"/>	<input checked="" type="radio"/>	
			MIXMODE	<input type="radio"/>	<input checked="" type="radio"/>	
			AITMODE	<input type="radio"/>	<input checked="" type="radio"/>	
			CEP	<input type="radio"/>	<input checked="" type="radio"/>	
			VLF	<input type="radio"/>	<input checked="" type="radio"/>	
			RPA	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Need Help</a>
			IMS	<input type="radio"/>	<input checked="" type="radio"/>	
			SPS	<input type="radio"/>	<input checked="" type="radio"/>	
			EPD	<input type="radio"/>	<input checked="" type="radio"/>	
			RLP	<input type="radio"/>	<input checked="" type="radio"/>	
			ASP	<input type="radio"/>	<input checked="" type="radio"/>	
			SWEPT FREQ.	either		<input type="button" value="▼"/>
			FIXED FREQ.	any of following		<input type="button" value="▼"/>

Press  to submit your request, or  to start over.

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# ISIS-2 DIGITAL TOPSIDE SOUNDER DATA SEARCH PAGE:

Search for fixed-frequency ionograms with sounder  
frequency = FH (electron gyrofrequency)

TYPE OF SEARCH:		PASS	IONO				
		MINIMUM	MAXIMUM	ON	OFF		
Year (YYDDD)	<input type="text"/>	<input type="text"/>	D MODE	<input type="radio"/>	<input checked="" type="radio"/>	STATION CODE	<input type="text"/>
UT (HHMM)	<input type="text"/>	<input type="text"/>	G MODE	<input checked="" type="radio"/>	<input type="radio"/>	ORBIT NUMBER	<input type="text"/>
LMT (HHMM)	<input type="text"/>	<input type="text"/>	MIX MODE	<input type="radio"/>	<input checked="" type="radio"/>	SUNLIGHT	yes <input type="radio"/> no <input checked="" type="radio"/>
MLT (HHMM)	<input type="text"/>	<input type="text"/>	AIT MODE	<input type="radio"/>	<input checked="" type="radio"/>		
DIP (-90 to 90)	<input type="text"/>	<input type="text"/>	CEP	<input type="radio"/>	<input checked="" type="radio"/>		
CHI (0 to 180)	<input type="text"/>	<input type="text"/>	VLF	<input type="radio"/>	<input checked="" type="radio"/>		
GGLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	RPA	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Need Help</a>	
GGLON (-180 to 180)	<input type="text"/>	<input type="text"/>	IMS	<input type="radio"/>	<input checked="" type="radio"/>		
HGT (1300-1500 km)	<input type="text"/>	<input type="text"/>	SPS	<input type="radio"/>	<input checked="" type="radio"/>		
GMLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	EPD	<input type="radio"/>	<input checked="" type="radio"/>		
GMLON (-180 to 180)	<input type="text"/>	<input type="text"/>	RLP	<input type="radio"/>	<input checked="" type="radio"/>		
FH (0.3 - 1.1 MHz)	<input type="text" value="0.47"/>	<input type="text" value="0.49"/>	ASP	<input type="radio"/>	<input checked="" type="radio"/>		
INVLAT (-90 to 90)	<input type="text"/>	<input type="text"/>	SWEPT FREQ.	<input type="button" value="either"/>			
L value	<input type="text"/>	<input type="text"/>	FIXED FREQ.	<input type="button" value="0.48 MHz"/>			

→      ←      ←

Press  to submit your request, or  to start over.

**SEARCH CRITERIA: IONOGRAM SEARCH FIXED FREQ.: 0.480 GMODE: ON**  
**FH: 0.47 0.49**

FILENAME	ORB	LMT	GGLAT	GGLON	ALT	MLT	INVLAT	L	DIP	FH	CHI	GMLAT	GMLON
STA YYYYDDDHHMMSS		(HHMM)	(DEG)	(DEG)	(KM)	(HHMM)	(DEG)			(DEG) (MHZ)	(DEG)	(DEG)	(DEG)
QUI_1973079180018	09116	1203	-4.67	-89.43	1366	1202	26.43	1.25	12	0.476	5	6.30	-20.49

**NUMBER OF HITS: 91**

**TOTAL NUMBER OF PASS HEADERS IN DATABASE: 7624**

**TOTAL NUMBER OF IONO HEADERS IN DATABASE: 337082**

**this search took 0.00 cpu second wall clock time is 3 seconds**

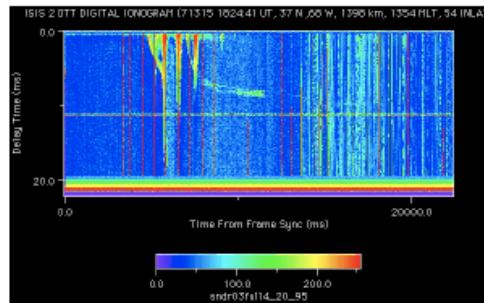


Sample output line  
(ionogram used in Figure 10  
of Muldrew [2006])

These results were used by Muldrew [2006] in his interpretation of the sounder-stimulated plasma resonance at the electron gyrofrequency fH

Return to the ISIS data-restoration home page to view the ionogram corresponding to the above sample output line

# ISIS data-restoration page showing link to view ionograms



## ISIS/Alouette Topside Sounder Data Restoration Project

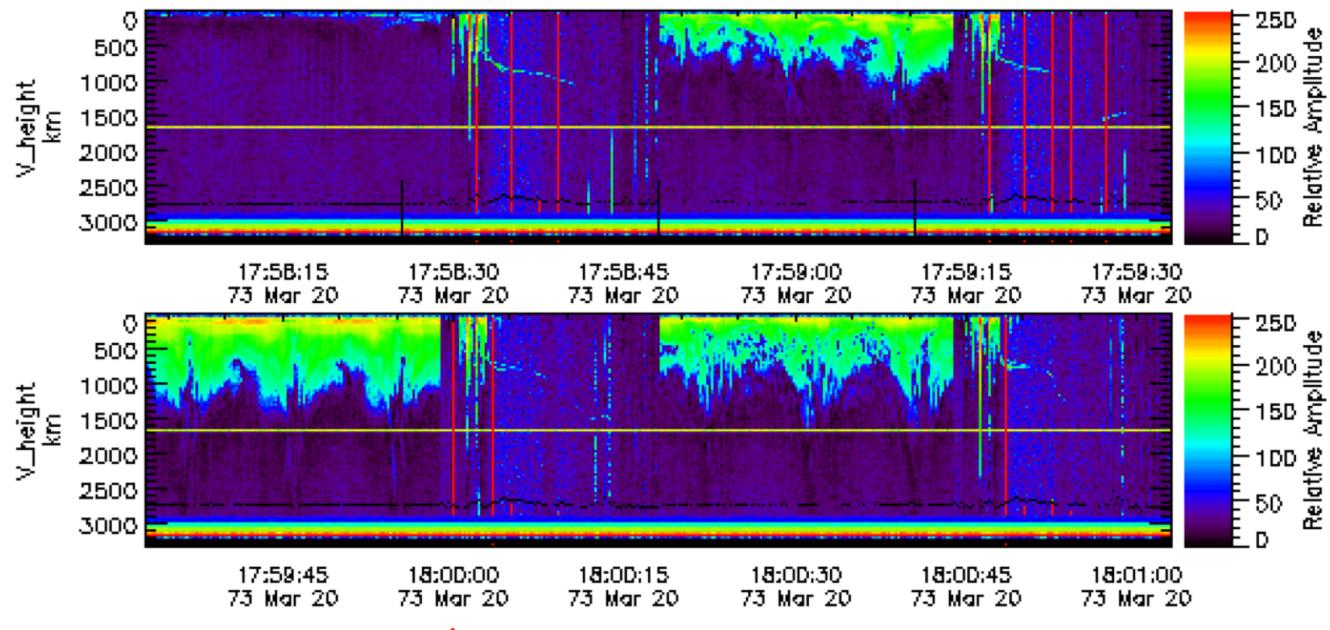
- Read about the project
  - [background information](#)
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- [Related software \(retrieve source code\)](#):

# Options for viewing Alouette/ISIS topside ionograms (presently, to view data, individual stations have to be selected)

- manually check/uncheck one or more data sets from the list below OR
- [Click here to CLEAR All checkboxes, OR](#)
- [Click here to SELECT All checkboxes](#)

- [I1 AV KER](#): ISIS-1 Topsider Sounder Ionograms over Kerguelen Island, France (Lat=-49, Long=70) -  
[Available Time Range: 1983/08/24 15:21:21 - 1983/12/30 15:19:33]
- [I1 AV KSH](#): ISIS-1 Topsider Sounder Ionogram over Kashima, Japan (lat/lon=36/141) - R.F. Benson ( -  
[Available Time Range: 1978/01/06 04:52:17 - 1981/12/30 16:22:49]
- [I1 AV KWA](#): ISIS-1 Topsider Sounder Ionogram over Kwajalein, Marshall Is. (lat/lon=9/168) - R.F. B  
[Available Time Range: 1978/01/03 04:13:25 - 1978/12/30 21:34:08]
- [I1 AV ODG](#): ISIS-1 Topsider Sounder Ionogram over Ouagadougou, Burkina Faso (lat/lon=14/359) - I  
[Available Time Range: 1969/02/03 13:27:25 - 1976/06/28 17:19:36]
- [I1 AV ORR](#): ISIS-1 Topsider Sounder Ionogram over Orroral, Australia (lat/lon=-36/149) - R.F. Bensc  
[Available Time Range: 1970/01/28 09:47:09 - 1981/08/24 14:00:56]
- [I1 AV OTT](#): ISIS-1 Topsider Sounder Ionogram over Ottawa, Canada (lat/lon=45/284) - R.F. Benson ( -  
[Available Time Range: 1969/01/30 14:50:12 - 1983/12/17 13:08:05]
- [I1 AV QUI](#): ISIS-1 Topsider Sounder Ionogram over Quito, Ecuador (lat/lon=-1/281) - R.F. Benson (N  
[Available Time Range: 1969/01/31 04:20:04 - 1978/06/22 04:44:35]

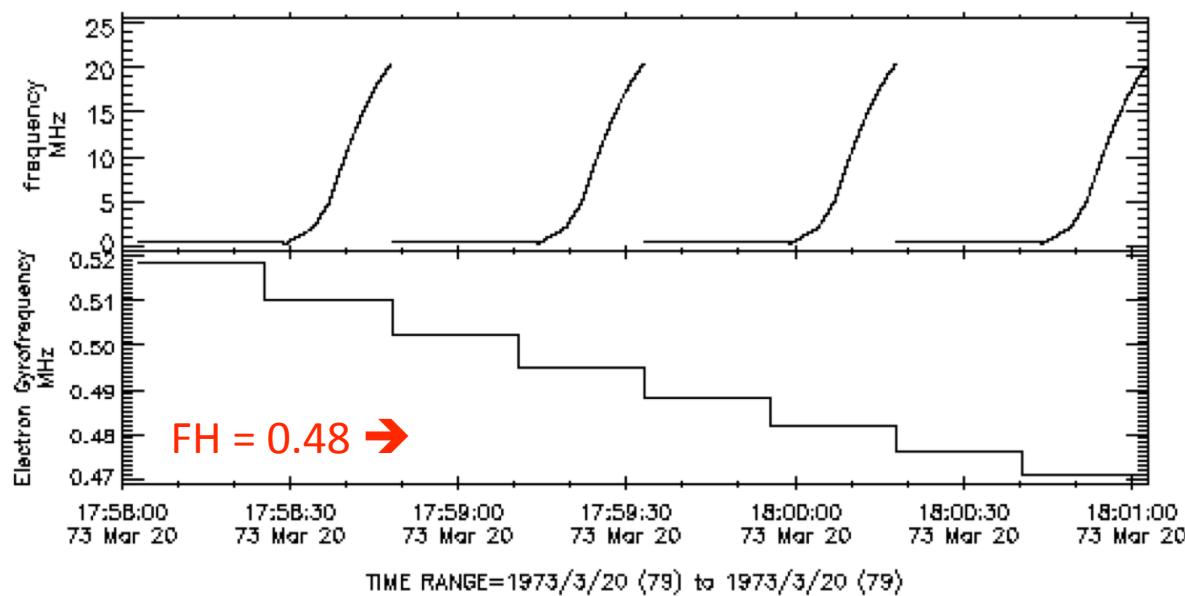
**Results from 3-minute request for QUI data from 1758 – 1801 UT on 20 March 1973**



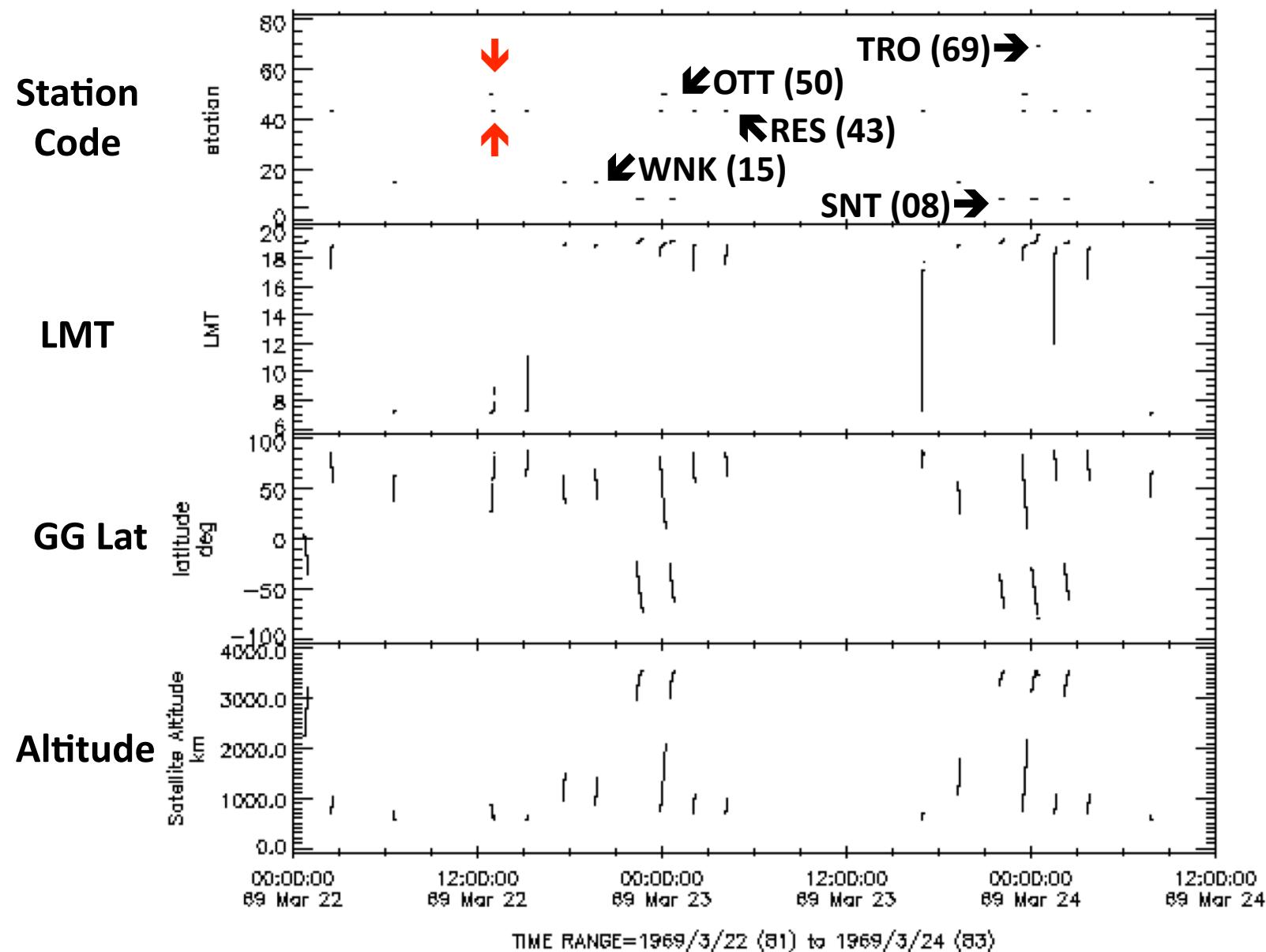
**Fixed- & fixed/swept- frequency ionograms used in Figure 10 of Muldrew [2006]**

**Good frequency data available (FF = 0.48; SF = 0.1 – 20 MHz)**

**Gyrofrequency (FH) from 0.47 – 0.52 MHz**

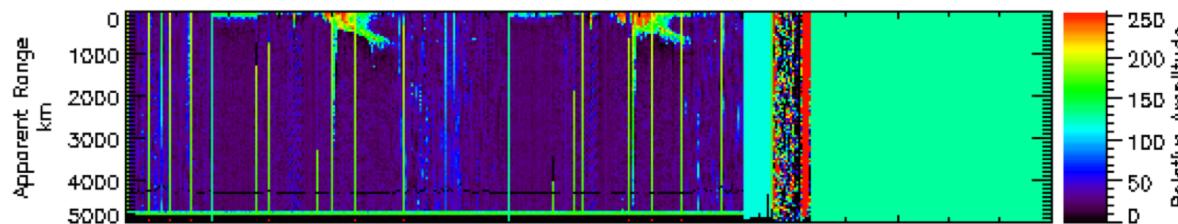


**New ISIS-data option resulting from a merged data set  
allowing for data selection by time independent of station  
(ISIS-1 data from 22 Mar 0000 UT – 24 Mar 1200 UT 1969)**

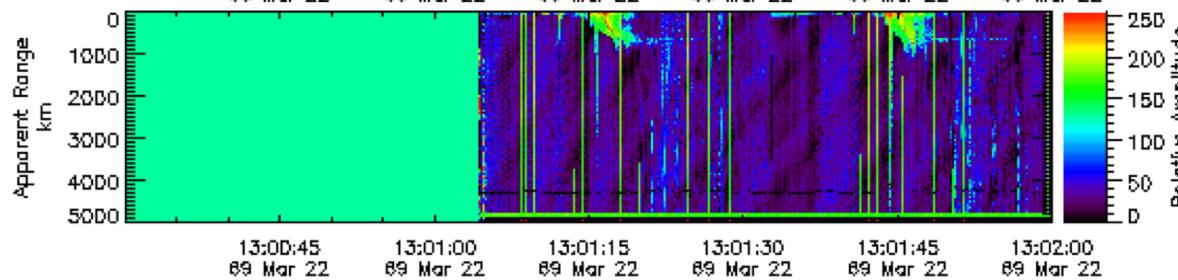


# ISIS-1 data from 1259 – 1302 UT on 22 Mar 1969

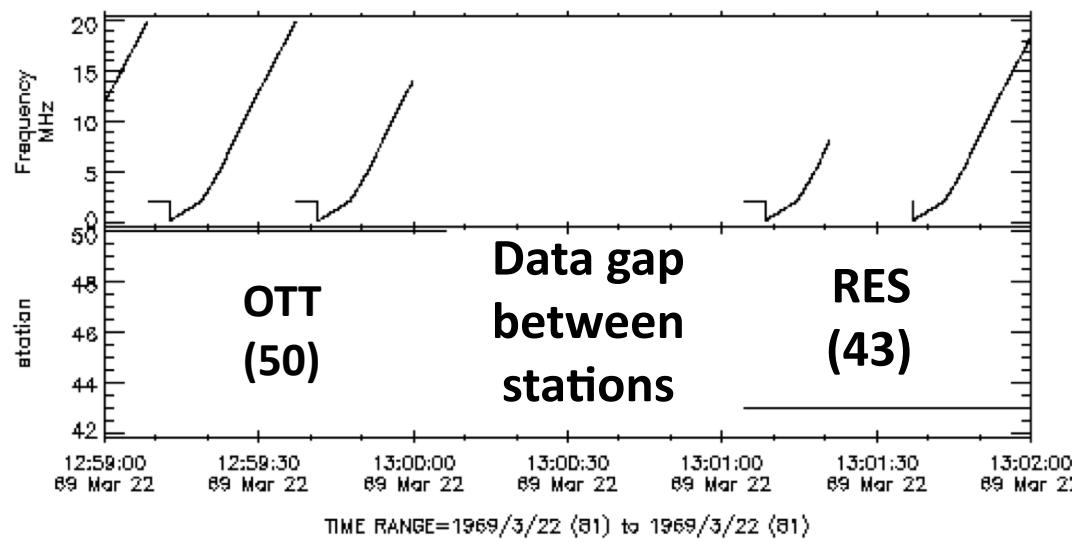
OTT  
ionograms



RES  
ionograms



Frequency  
information



Station Code

**The data presented so far was obtained from the ISIS data-restoration home page**

**We are now making these data available via the VWO**



# Virtual Wave Observatory

+ Home

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- + Stanford VLF Group
- + Swedish Institute of Space Physics, Uppsala (IRFU) Wave Group

### Information

# Virtual Wave Observatory

- QUERY + TUTORIALS + EDUCATION + ANNOTATION + EVENTS + RESOURCES

version: 2.3

Note:  
magnetospheric  
state can also be  
specified



Presently, only  
ISIS-1 wave  
data available  
from VWO  
during  
specified time  
range in 1969

+ Home

**Virtual Wave Observatory**

Time Range

Data Source

Magnetospheric State

Location

Measurement Type

Keyword

TIME:

1969-03-22T12:30:00.000Z

1969-03-22T13:30:00.000Z

## VWO Query Builder

### Sources Search

Restrict your query to the following available Data Sources  
then press Apply This Condition button

Data sources that are grey are available, but not for your chosen time range.

(i) Double click on a data source element to view its metadata.

Select Observatory Reset

Cluster Samba - SC3

Cluster Tango - SC4

Geotail

Hawkeye

IMAGE

ISIS-1

ISIS-2

POLAR

STEREO-A

STEREO-B

Select Instrument Reset

Geotail Plasma Wave Investigation (PWI)

Hawkeye

Hawkeye VLF

IMAGE

IMAGE Radio Plasma Imager (RPI)

ISIS-1

Swept-Frequency Sounder

ISIS-2

Swept-Frequency Sounder

POLAR

Select Data Product Reset

Hawkeye 22-sec VLF

IMAGE Radio Plasma Imager (RPI)

IMAGE RPI Daily Dynamic Spectrogram Plots

IMAGE RPI Dynamic Spectrogram Data

Swept-Frequency Sounder

ISIS-1 Topsider Sounder Ionogram Data

Swept-Frequency Sounder

ISIS-2 Topsider Sounder Ionogram Data

POLAR Plasma Waves Investigation (PWI)

Polar PWI SFR-A Daily Dynamic Spectrograms

**Partial file listing resulting from VWO query request for ISIS-1 ionogram data over time interval between the OTT and RES coverage near 1300 UT on 22 Mar 1969**

- Last OTT ionogram of ISIS-1 pass over station** →
- First RES ionogram of ISIS-1 pass over station** →
- The plot option was employed to produce ionograms for the above two files**

Date/Time: 1969/03/22 12:58:39

Data File: i1\_av\_ott\_1969081125839\_v01.cdf  
Plot

Date/Time: 1969/03/22 12:59:08

Data File: i1\_av\_ott\_1969081125908\_v01.cdf  
Plot

Date/Time: 1969/03/22 12:59:37

Data File: i1\_av\_ott\_1969081125937\_v01.cdf  
Plot

Date/Time: 1969/03/22 13:01:04

Data File: i1\_av\_res\_1969081130104\_v01.cdf  
Plot

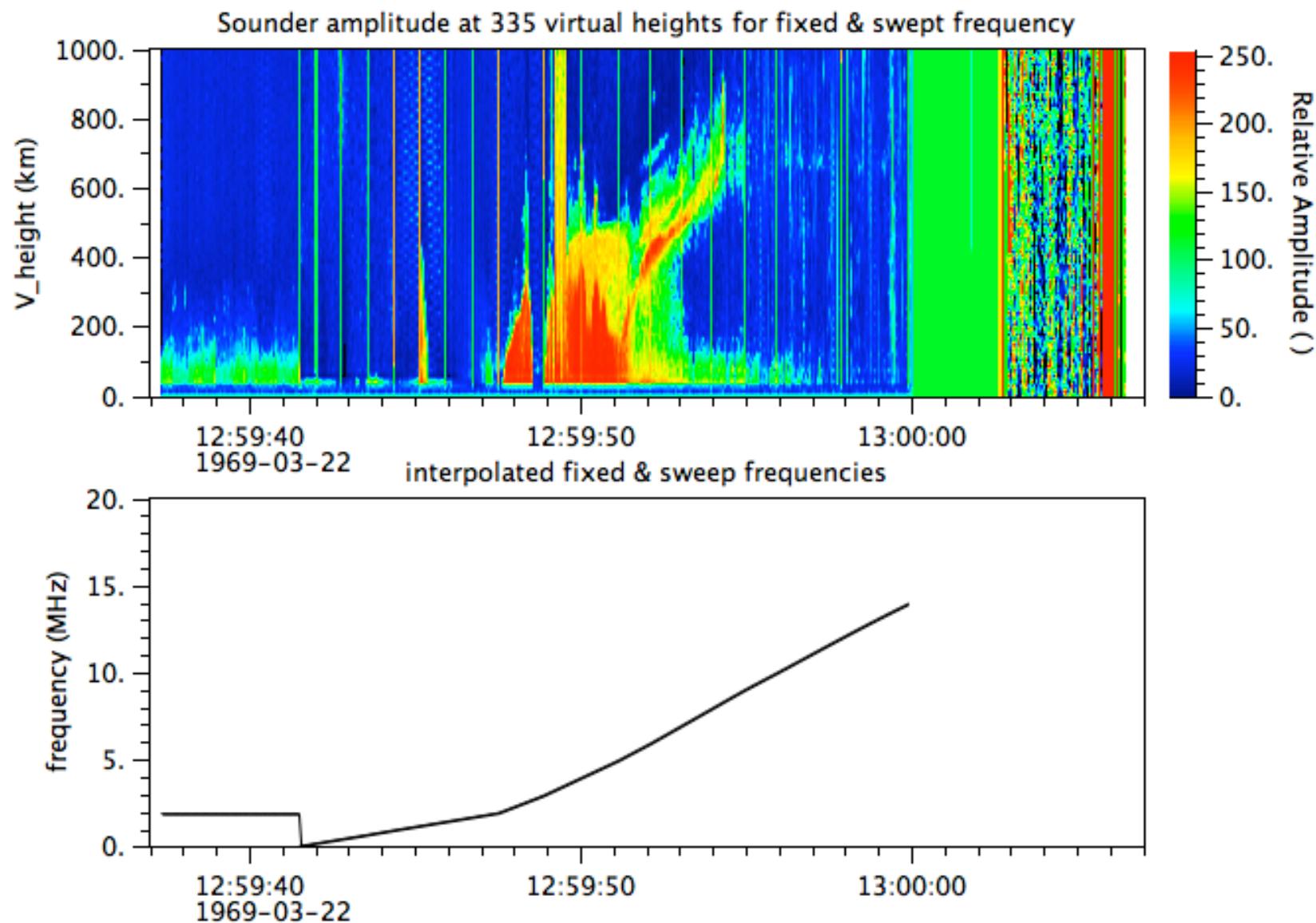
Date/Time: 1969/03/22 13:01:20

Data File: i1\_av\_res\_1969081130120\_v01.cdf  
Plot

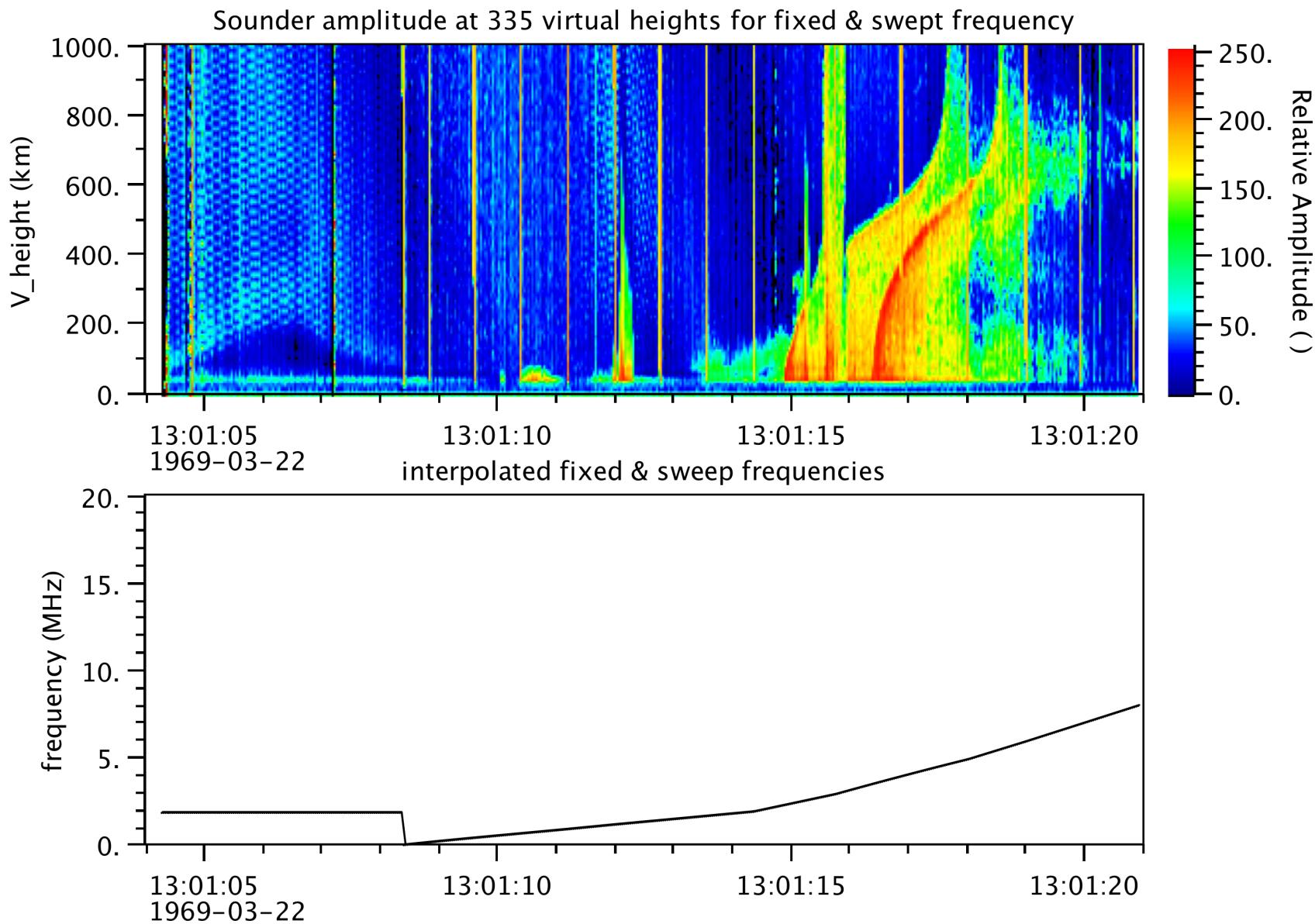
Date/Time: 1969/03/22 13:01:36

Data File: i1\_av\_res\_1969081130136\_v01.cdf  
Plot

# ISIS-1 OTT ionogram from 1259:37 UT, 22 March 1969 obtained from the VWO



# ISIS-1 RES ionogram from 1301:04UT, 22 March 1969 obtained from the VWO



## **Summary**

- The Virtual Wave Observatory (VWO) is a valuable tool for research with wave data that now includes ISIS topside-sounder data
- The digital form of the Alouette-2, ISIS-1, and ISIS-2 topside-sounder ionogram data enables efficient searching by time, geographic & geomagnetic location, instrument mode and magnetospheric state
- This search capability has provided data for fundamental scientific advances
- The new ISIS merged data files on CDAWeb allow the viewing of ISIS topside-sounder data over time intervals independent of station selection
- The ISIS ionogram data access via the VWO offers a similar file listing in time order independent of station
- We encourage investigators to make their space-borne sounder data sets accessible to the scientific community via the VWO